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EXAMINER	
MARKHAM, WESLEY D	
ART UNIT	PAPER NUMBER
1762	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No. 09/801,542	Applicant(s) BONDESTAM ET AL.	
	Examin r Wesley D Markham	Art Unit 1762	

-- The MAILING DATE of this communication appears on th cover sheet with th correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-30,35,37-48 and 50-57* is/are pending in the application.

4a) Of the above claim(s) *1-30* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *35,37-48 and 50-57* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *07 March 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Response to Amendment

1. Acknowledgement is made of applicant's amendment A, filed as paper #10 on 4/18/2003 (with a certificate of mailing dated 4/14/2003), in which the specification of the instant application was amended, Claims 35, 37, 39, 43, 44, and 50 were amended, Claims 31 – 34, 36, and 49 were canceled, and Claim 57 was added. Claims 1 – 30 stand withdrawn, without traverse, from consideration by the examiner as being drawn to a non-elected invention pursuant to the applicant's response to a restriction requirement. Claims 1 – 30, 35, 37 – 48, and 50 – 57 are currently pending in U.S. Application Serial No. 09/801,542, and an Office Action on the merits follows.

Drawings

2. The formal drawings (8 sheets, 8 figures) filed on 3/7/2001 are acknowledged and approved by the examiner.

Specification

3. The objection to the specification, set forth in paragraph 4 of the previous Office Action (i.e., the non-final Office Action, paper #9, mailed on 11/14/2002), is withdrawn in light of applicant's amendment A in which the specification was amended to capitalize the trademarks used therein.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. The rejection of Claims 50 – 56 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, set forth in paragraph 6 of the previous Office Action, is withdrawn in light of applicant's amendment A in which an antecedent basis issue in independent Claim 50 was clarified.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in the previous Office Action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. The rejection of Claims 31 and 43 under 35 U.S.C. 102(e) as being anticipated by Kim et al. (USPN 6,306,216 B1), set forth in paragraph 10 of the previous Office Action, is withdrawn in light of applicant's amendment A in which independent Claim 31 was canceled and Claim 43 was amended to depend from Claim 35.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. The rejection of Claims 32 and 33 under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1), set forth in paragraph 14 of the previous Office Action, is withdrawn in light of applicant's amendment A in which Claims 32 and 33 were canceled.

11. Claims 35, 37, 38, 43 – 45, and 50 – 56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1) in view of Suntola et al. (USPN 6,015,590) and Yokoyama et al. (USPN 4,897,709).

12. Regarding independent Claim 35, Kim et al. teaches a method for growing a thin film on a substrate by exposing the substrate in a reaction chamber defined by a plurality of walls to alternate surface reactions of vapor phase reactants (Abstract, Figures 2 and 4a, Col.1, lines 8 – 15, Col.2, lines 8 – 28, Col.4, lines 2 – 7 and 35 – 65, Col.5, lines 1 – 10, and Col.11, lines 13 – 25 and 41 – 45), the method comprising controlling a chamber wall temperature of at least those portions of the chamber walls that are exposed to vapor-phase reactants (Figure 2, reference number "400", Figure 4a, reference numbers "705", "705a", and "705b", Col.3, lines 49 – 52, Col.4, lines 18 – 21, and Col.8, lines 17 – 59), loading the substrate onto a support structure inside the reaction chamber (Figures 2 and 4a, Col.6, lines 43 – 67, Col.7, lines 1 – 16 and 60 – 67, and Col.8, lines 1 – 10), controlling a substrate support temperature independently of the chamber wall temperature (Figure 4a, reference number "702", Col.8, lines 16 – 64, Col.9, lines 66 – 67, and Col.10, lines 1 – 14), and alternately and sequentially feeding at least two vapor phase reactants into the reaction chamber (Abstract, Col.4, lines 2 – 7 and 35 – 65, Col.5, lines 1 – 10, and Col.11, lines 13 – 25 and 41 – 45). Kim et al. does not explicitly teach that (1) the substrate support temperature is maintained at a first temperature and the chamber wall temperature is maintained at a second temperature different from the substrate support temperature, and (2) a difference between the first temperature and the

second temperature is selected to maintain a lower rate of film growth upon the chamber walls as compared to the substrate. However, Kim et al. is concerned with depositing a thin film on a substrate using an atomic layer deposition (ALD) process (Abstract). Suntola et al. teaches that, in an ALD process, it is desirable to use a "hot-wall" reactor system so that an atom or molecule species impinging on the reactor wall <u>will not condense thereon</u> and may become re-vaporized, whereby advantageous conditions are created for repeated impingement of the species on the substrate. This "multi-shot" principle can provide improved material utilization efficiency (Col.2, lines 42 – 54). Yokoyama et al. teaches that, in the art of vapor deposition, a "hot-wall" reactor system / method is one in which the <u>temperature of the reaction chamber walls is higher than that of the substrate</u> (Col.2, lines 63 – 66). Therefore, it would have been obvious to one of ordinary skill in the art to utilize the "hot-wall" reactor principle (i.e., to heat the chamber walls of Kim et al. to a temperature higher than the substrate support temperature) in the process of Kim et al. with the reasonable expectation of successfully and advantageously preventing atomic or molecular species from condensing on the reactor walls (i.e., preventing contamination of the reactor walls) and allowing the reactive species to become "re-vaporized", thereby creating a "multi-shot" effect that provides improved material utilization efficiency. Further, the combination of Kim et al., Suntola et al., and Yokoyama et al. is clearly drawn to successfully depositing a film by ALD on a substrate while preventing undesired contamination of the reactor walls. In other words, Suntola et al. teaches that the walls of the reactor should be kept hot so that

the re-vaporized species from the walls can repeatedly impinge on the substrate, creating the desired "multi-shot" principle – this "multi-shot" principle (i.e., the goal of using a "hot-wall") would not be achieved if the vaporized material undesirably deposited on the walls by any mechanism (i.e., condensation, decomposition, etc.) Therefore, it would have been obvious to one of ordinary skill in the art to choose a reactor wall temperature that, while higher than the substrate temperature (i.e., in the "hot-wall" process / system taught by Suntola et al.) is below the thermal decomposition temperature of the reactants in order to prevent contamination of the reactor walls as desired by Kim et al. and Suntola et al. In other words, it would have been obvious to one of ordinary skill in the art to select the substrate temperature and the reactor wall temperature (i.e., and thus the difference between the substrate and reactor wall temperatures) to maintain a lower rate of film growth upon the chamber walls as compared to the substrate with the reasonable expectation of (1) success, as Kim et al. teaches that the substrate and reactor wall temperatures can be separately controlled in their ALD process / device, and (2) advantageously depositing a film by ALD on the substrate while achieving the desired "multi-shot" principle taught by Suntola et al.

13. The combination of Kim et al., Suntola et al., and Yokoyama et al. also teaches / suggests all the limitations of Claims 37, 38, and 43 as set forth above in paragraph 12 and below, including a method wherein / further comprising:

- Claim 37: The chamber wall temperature is maintained higher than the substrate support temperature (see paragraph 12 above).

- Claim 38: The chamber wall temperature is controlled at a level low enough to prevent thermal decomposition of the reactants. While this limitation is not explicitly taught by the aforementioned combination of references, the combination is clearly drawn to successfully depositing a film by ALD on a substrate while achieving the "multi-shot" principle and preventing undesired contamination of the reactor walls. Therefore, it would have been obvious to one of ordinary skill in the art to choose a reactor wall temperature that is below the thermal decomposition temperature of the reactants in order to prevent contamination of the reactor walls as desired by Kim et al. and Suntola et al. For further explanation, see paragraph 12 above.
- Claim 43: The chamber wall temperature is maintained higher than a temperature of the reactants as they enter the reaction chamber (Col.8, lines 51 – 52, and Col.12, lines 8 – 11 of Kim et al.).

14. The combination of Kim et al., Suntola et al., and Yokoyama et al. teaches all the limitations of independent Claim 44 as set forth above in paragraph 12. Please note that the "first temperature controller" and the "second temperature controller" required by independent Claim 44 correspond to the wafer heating unit and the reaction chamber heating unit, respectively, of Kim et al. Regarding dependent Claim 45, the combination of Kim et al., Suntola et al., and Yokoyama et al. also teaches that the second temperature is maintained higher than the first temperature (see paragraphs 12 and 13 above).

15. Regarding independent Claim 50 (from which Claims 51 – 56 depend), the combination of Kim et al., Suntola et al., and Yokoyama et al. teaches a method for preventing unwanted deposition on walls of an ALD reaction chamber (see Figures 2 and 4a of Kim et al., and paragraphs 12 and 13 above), the method comprising controlling a temperature of the substrate and independently controlling a temperature of at least those portions of the chamber walls exposed to reactants (see paragraphs 12 and 13 above), such that a rate of deposition by self-limited ALD on the substrate is maximized while film growth on the walls is reduced relative to controlling a temperature of the substrate alone (see paragraphs 12 and 13 above). Regarding Claims 51 and 52, Kim et al. also teaches that controlling the chamber wall temperature comprises heating the chamber walls (reference numbers "705", "705a", and "705b", and Col.8, lines 43 – 59), and controlling the substrate temperature comprises heating the substrate (reference number "702" and Col.8, lines 17 – 39). Regarding Claim 53, the combination of Kim et al., Suntola et al., and Yokoyama et al. does not explicitly teach controlling the wall temperature in a range to accomplish ALD upon the walls. However, as set forth in paragraph 14 of the previous Office Action, it would have been obvious to one of ordinary skill in the art to control the chamber wall temperature and the substrate support temperature of Kim et al. to be approximately equal. In this case, since (1) the chamber wall temperature and the substrate support temperature are approximately equal, and (2) ALD occurs on the substrate (see Abstract of Kim et

al.), the wall temperature is <u>necessarily</u> controlled in a range to accomplish ALD upon the walls (i.e., it is controlled in the same range as the substrate upon which ALD is accomplished). Regarding Claim 54, Suntola et al. teaches controlling the wall temperature in a range to avoid condensation and physisorption of reactants upon the walls (Col.2, lines 42 – 54). Regarding Claim 55, the aforementioned combination of references does not explicitly teach controlling the wall temperature in a range to avoid thermal decomposition of reactants upon the walls. However, the combination of references is clearly drawn to successfully depositing a film by ALD on a substrate while achieving the desired "multi-shot" principle, thereby preventing undesired contamination of the reactor walls. Therefore, it would have been obvious to one of ordinary skill in the art to choose a reactor wall temperature that is below the thermal decomposition temperature of the reactants in order to prevent contamination of the reactor walls and achieve the "multi-shot" principle taught by Suntola et al., as desired by Kim et al. and Suntola et al. For further explanation, please see paragraph 12 above. Regarding Claim 56, the combination of Kim et al., Suntola et al., and Yokoyama et al. teaches maintaining the wall temperature in a range to reduce film growth upon the walls relative to deposition rates upon the substrate (see explanation regarding Claim 35 above).

16. Claims 46 and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1) in view of Suntola et al. (USPN 6,015,590) and

Yokoyama et al. (USPN 4,897,709), and in further view of Tseng (USPN 5,811,762).

17. The combination of Kim et al., Suntola et al., and Yokoyama et al. teaches all the limitations of Claims 46 and 47 as set forth above in paragraph 14, except for a method wherein maintaining the first temperature (i.e., the substrate support temperature) comprises removing heat from the substrate support by circulating a fluid through the substrate support. However, the combination of references does suggest heating the chamber walls of Kim et al. to a temperature higher than the substrate support temperature (see paragraph 12 above). Tseng teaches a substrate support for use in vapor deposition systems in which cooling gas, cooling water, and heated gas are utilized to bring a semiconductor wafer to a desired high or low temperature. The substrate support of Tseng has the benefits of (1) allowing a rapid transition from one temperature to another, and (2) achieving precise temperature control over a wide range, thereby yielding increased flexibility of process control (Abstract). Therefore, it would have been obvious to one of ordinary skill in the art to utilize a substrate support as taught by Tseng (i.e., with cooling water / cooling gas circulating through the substrate support) in the process of Kim et al. in order to achieve a situation in which the chamber walls of Kim et al. are heated to a temperature higher than the substrate support temperature, as suggested by the aforementioned combination of references. By utilizing such a substrate support, one of ordinary skill in the art would have realized the benefits of allowing a rapid transition from one temperature to another and achieving precise

temperature control over a wide range, thereby yielding increased flexibility of process control.

18. Claim 57 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1) in view of Suntola et al. (USPN 6,015,590) and Yokoyama et al. (USPN 4,897,709), and in further view of Lopatin et al. (USPN 6,368,954 B1).
19. The combination of Kim et al., Suntola et al., and Yokoyama et al. teaches all the limitations of Claim 57 as set forth above in paragraph 12, except for a method wherein the temperature of the substrate is maintained within an ALD temperature window such that <u>approximately one monolayer</u> is deposited per full cycle. Regarding the limitation that the chamber wall temperature is maintained either (1) above a lower temperature limit at which condensation takes place on the chamber walls and below the ALD temperature window, or (2) below a high temperature limit at which thermal decomposition causes deposition on the chamber walls and above the ALD temperature window, the combination of Kim et al., Suntola et al., and Yokoyama et al. reasonably suggests this limitation. Specifically, the combination of Kim et al., Suntola et al., and Yokoyama et al. reasonably suggests utilizing the "hot-wall" reactor principle (i.e., heating the chamber walls of Kim et al. to a temperature higher than the substrate support temperature) in the process of Kim et al. with the reasonable expectation of successfully and advantageously preventing atomic or molecular species from condensing on the reactor walls (i.e., preventing contamination of the reactor walls) and allowing the reactive species to become "re-

vaporized", thereby creating a "multi-shot" effect that provides improved material utilization efficiency. If the reactor wall temperature was either within the ALD temperature window or above a temperature at which thermal decomposition caused deposition on the chamber walls, the reactive species would clearly not be re-vaporized from the chamber walls, thereby eliminating or reducing the "multi-shot" principle taught to be desirable in ALD by Suntola et al. Therefore, it would have been obvious to one of ordinary skill in the art to maintain the chamber wall temperature of the combination of Kim et al., Suntola et al., and Yokoyama et al. below a high temperature limit at which thermal decomposition would cause deposition on the chamber walls and above the ALD temperature window in order to achieve the "multi-shot" principle of Suntola et al., which advantageously improves material utilization efficiency in an ALD process. Regarding the "approximately one monolayer" limitation, the combination of Kim et al., Suntola et al., and Yokoyama et al. is, in general, drawn to depositing a thin film on a substrate by using an ALD process. Lopatin et al. teaches that the <u>primary feature of ALD</u> is the formation of layers by a multiplicity of process cycles in which each cycle produces an essentially equivalent monolayer of an appropriate film (Col.4, lines 42 – 48, and Col.5, lines 51 – 60). Therefore, it would have been obvious to one of ordinary skill in the art to maintain the temperature of the substrate within an ALD temperature window such that <u>approximately one monolayer</u> is deposited per full cycle (as taught by Lopatin et al.) with the reasonable expectation of (1) success, as Kim et al. teaches an ALD process / system in which the temperature of the substrate can

be controlled, and (2) using a substrate temperature that can successfully deposit thin films by ALD on the substrate (as desired by Kim et al. and Suntola et al.) and achieve the primary goal of ALD, which is depositing approximately one monolayer of material per process cycle, as taught by Lopatin et al.

20. Claims 35, 39 – 41, 43, 44, 48, and 50 – 56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1) in view of Eichman et al. (USPN 5,348,587).

21. Regarding independent Claim 35, Kim et al. teaches a method for growing a thin film on a substrate by exposing the substrate in a reaction chamber defined by a plurality of walls to alternate surface reactions of vapor phase reactants (Abstract, Figures 2 and 4a, Col.1, lines 8 – 15, Col.2, lines 8 – 28, Col.4, lines 2 – 7 and 35 – 65, Col.5, lines 1 – 10, and Col.11, lines 13 – 25 and 41 – 45), the method comprising controlling a chamber wall temperature of at least those portions of the chamber walls that are exposed to vapor-phase reactants (Figure 2, reference number "400", Figure 4a, reference numbers "705", "705a", and "705b", Col.3, lines 49 – 52, Col.4, lines 18 – 21, and Col.8, lines 17 – 59), loading the substrate onto a support structure inside the reaction chamber (Figures 2 and 4a, Col.6, lines 43 – 67, Col.7, lines 1 – 16 and 60 – 67, and Col.8, lines 1 – 10), controlling a substrate support temperature independently of the chamber wall temperature (Figure 4a, reference number "702", Col.8, lines 16 – 64, Col.9, lines 66 – 67, and Col.10, lines 1 – 14), and alternately and sequentially feeding at least two vapor phase reactants

into the reaction chamber (Abstract, Col.4, lines 2 – 7 and 35 – 65, Col.5, lines 1 – 10, and Col.11, lines 13 – 25 and 41 – 45). Kim et al. does not explicitly teach that (1) the substrate support temperature is maintained at a first temperature and the chamber wall temperature is maintained at a second temperature different from the substrate support temperature, and (2) a difference between the first temperature and the second temperature is selected to maintain a lower rate of film growth upon the chamber walls as compared to the substrate. However, Kim et al. is concerned with depositing a thin film on a substrate using an atomic layer deposition (ALD) process (Abstract). Eichman et al. teaches that, in the art of manufacturing semiconductor devices by using a vapor deposition process, it is desirable to elevate (i.e., heat) the surface of the wafer to a reaction temperature while maintaining other parts of the reactor at a lower temperature, which prevents the deposition of coating material on surfaces other than on the surface of the substrate to be coated (Col.1, lines 18 – 34). Therefore, it would have been obvious to one of ordinary skill in the art to heat the surface of the wafer of Kim et al. to a desired reaction temperature while maintaining other parts of the reactor (e.g., the chamber walls) at a lower temperature with the reasonable expectation of successfully preventing deposition of reaction materials on surfaces other than the substrate surface (i.e., the chamber walls). By maintaining the reactor walls at a temperature lower than the substrate temperature and minimizing deposition on the reactor walls (i.e., selecting a difference between the substrate temperature and the wall temperature to achieve a lower rate of film growth upon the chamber walls as

compared to the substrate), one achieves the benefits of (1) preventing interference with reactor operation and (2) preventing substrate contamination (Col.1, lines 40 – 42 of Eichman et al.).

22. The combination of Kim et al. and Eichman et al. also teaches all the limitation of Claims 39 – 41 and 43 as set forth above in paragraph 21 and below, including a method wherein / further comprising:
    - Claim 39 – The chamber wall temperature is maintained lower than the substrate support temperature (see paragraph 21 above).
    - Claims 40 and 41 – The chamber wall temperature is controlled at a level high enough to prevent condensation and physisorption of one of the reactants on the wall. While this limitation is not explicitly taught by the aforementioned combination of references, the combination is clearly drawn to successfully depositing a film on a substrate while preventing undesired deposition on / contamination of the reactor walls. In other words, Eichman et al. teaches that, by minimizing deposition on the reactor walls, one achieves the benefits of preventing interference with reactor operation and preventing substrate contamination. Therefore, it would have been obvious to one of ordinary skill in the art to utilize a chamber wall temperature that is high enough to prevent condensation and physisorption of one of the reactants on the wall in order to prevent contamination (i.e., contamination by any mechanism, including deposition, condensation, physisorption, etc.) of the reactor walls as desired by Kim et al. and Eichman et al.

- Claim 43 – The chamber wall temperature is maintained higher than a temperature of the reactants as they enter the reaction chamber (Col.8, lines 51 – 52, and Col.12, lines 8 – 11 of Kim et al.).

23. The combination of Kim et al. and Eichman et al. teaches all the limitations of independent Claim 44 as set forth above in paragraph 21. Please note that the "first temperature controller" and the "second temperature controller" required by independent Claim 44 correspond to the wafer heating unit and the reaction chamber heating unit, respectively, of Kim et al. Regarding dependent Claim 48, the combination of Kim et al. and Eichman et al. also teaches that the second temperature is maintained lower than the first temperature (see paragraphs 21 and 22 above).

24. Regarding independent Claim 50 (from which Claims 51 – 56 depend), the combination of Kim et al. and Eichman et al. teaches a method for preventing unwanted deposition on walls of an ALD reaction chamber (see Figures 2 and 4a of Kim et al. and paragraph 21 above), the method comprising controlling a temperature of the substrate and independently controlling a temperature of at least those portions of the chamber walls exposed to reactants (see paragraph 21 above), such that a rate of deposition by self-limited ALD on the substrate is maximized while film growth on the walls is reduced relative to controlling a temperature of the substrate alone (see paragraphs 21 and 22 above). Regarding

Claims 51 and 52, Kim et al. also teaches that controlling the chamber wall temperature comprises heating the chamber walls (reference numbers "705", "705a", and "705b", and Col.8, lines 43 – 59), and controlling the substrate temperature comprises heating the substrate (reference number "702" and Col.8, lines 17 – 39). Regarding Claim 53, the combination of Kim et al. and Eichman et al. does not explicitly teach controlling the wall temperature in a range to accomplish ALD upon the walls. However, as set forth in paragraph 14 of the previous Office Action, it would have been obvious to one of ordinary skill in the art to control the chamber wall temperature and the substrate support temperature of Kim et al. to be approximately equal. In this case, since (1) the chamber wall temperature and the substrate support temperature are approximately equal, and (2) ALD occurs on the substrate (see Abstract of Kim et al.), the wall temperature is <u>necessarily</u> controlled in a range to accomplish ALD upon the walls (i.e., it is controlled in the same range as the substrate upon which ALD is accomplished). Regarding Claims 54 and 55, the combination of Kim et al. and Eichman et al. does not explicitly teach controlling the wall temperature in a range to avoid condensation, physisorption, and thermal decomposition of reactants upon the walls. However, the combination of references is clearly drawn to successfully depositing a film by ALD on a substrate while preventing undesired deposition on and contamination of the reactor walls. In other words, Eichman et al. teaches that, by maintaining the temperature of reactor components (e.g., walls) at a lower temperature than the temperature of the substrate (i.e., the reaction temperature), deposition of coating material on surfaces

other than on the surface of the substrate to be coated is prevented. By doing so, one achieves the benefits of preventing interference with reactor operation and preventing substrate contamination due to undesired deposition on reactor components. Therefore, it would have been obvious to one of ordinary skill in the art to choose a reactor wall temperature that prevents condensation, physisorption, and thermal decomposition of the reactants on the reactor walls in order to prevent undesired deposition on and contamination of the reactor walls, as desired by Kim et al. and Eichman et al. Regarding Claim 56, the combination of Kim et al. and Eichman et al. teaches maintaining the wall temperature in a range to reduce film growth upon the walls relative to deposition rates upon the substrate (see explanation regarding Claim 35 in paragraph 21 above).

25. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (USPN 6,306,216 B1) in view of Eichman et al. (USPN 5,348,587), and in further view of Kukli et al. (*J. Electrochem. Soc.*).

26. The combination of Kim et al. and Eichman et al. teaches all the limitations of Claim 42 as set forth above in paragraphs 21 and 22, except for a method wherein one of the reactants is water and the wall is maintained at a temperature of 200° C or higher. Please note that Kim et al. does teach that the reactor walls can have a temperature of, for example, 300° (Col.8, lines 51 – 53). In addition, the process / apparatus of Kim et al. is not drawn or limited to any specific ALE process (i.e., with any specific reactants) but is open to an ALE process in general (Abstract). Further,

the process / apparatus of Kim et al. quickly forms uniform thin films on wafer substrates while controlling the thickness of the thin films deposited on the wafers (Col.3, lines 6 – 21). Kukli et al. teaches that it was known in the art at the time of the applicant's invention to utilize ALE (i.e., the process taught by Kim et al.) in order to deposit a tantalum oxide thin film from $Ta(OC_2H_5)_5$ and water (Abstract). In this process, the reactor walls are advantageously kept between 225° C and 325° C (i.e., above 200° C) in order to achieve an optimum deposition rate without increasing the temperature to a point at which "CVD-like" growth occurs (page 1671 and Figure 2). It would have been obvious to one of ordinary skill in the art to utilize the process of the combination of Kim et al. and Eichman et al. to deposit the tantalum oxide film of Kukli et al. with the reasonable expectation of (1) success, as the process / apparatus of Kim et al. is not limited to any specific ALE process but is open to an ALE process in general, and (2) obtaining the benefits of using the process of the combination of Kim et al. and Eichman et al., such as preventing unwanted contamination and deposition on the reactor walls and quickly forming uniform thin films.

Response to Arguments

27. The applicant's arguments filed on 4/18/2003 have been fully considered but are not persuasive.

28. Regarding Claims 31 – 43, the applicant argues that the cited combination of Kim et al., Suntola et al., and Yokoyama et al. does not disclose that the temperature of the

chamber walls is selected "to maintain a lower rate of film growth upon the chamber walls as compared to the substrate" because maintaining the reaction chamber at a temperature above the substrate may result in increased deposition when thermal decomposition causes deposition. The applicant makes similar arguments regarding Claims 44 – 49 and 50 – 56.

29. In response, the examiner disagrees. Specifically, the combination of Kim et al., Suntola et al., and Yokoyama et al. at least <u>reasonably suggests to one of ordinary skill in the art</u> that the temperature of the chamber walls should be selected "to maintain a lower rate of film growth upon the chamber walls as compared to the substrate". For example, Suntola et al. teaches that, in an ALD process (i.e., a process analogous to that of Kim et al.), it is desirable to use a "hot-wall" reactor system so that an atom or molecule species impinging on the reactor wall <u>will not condense thereon</u> and may become re-vaporized, whereby advantageous conditions are created for repeated impingement of the species on the substrate. This "multi-shot" principle can provide improved material utilization efficiency (Col.2, lines 42 – 54). As is known in the art (as evidenced by Yokoyama et al.), a "hot-wall" reactor system / method is one in which the temperature of the reaction chamber walls is higher than that of the substrate (Col.2, lines 63 – 66). Therefore, it would have been obvious to one of ordinary skill in the art to utilize the "hot-wall" reactor principle (i.e., to heat the chamber walls of Kim et al. to a temperature higher than the substrate support temperature) in the process of Kim et al. with the reasonable expectation of successfully and advantageously preventing atomic or molecular

species from condensing on the reactor walls (i.e., preventing contamination of the reactor walls) and allowing the reactive species to become "re-vaporized", thereby creating a "multi-shot" effect that provides improved material utilization efficiency. Further, the combination of Kim et al., Suntola et al., and Yokoyama et al. is clearly drawn to successfully depositing a film by ALD on a substrate while preventing undesired contamination of the reactor walls. In other words, Suntola et al. teaches that the walls of the reactor should be kept hot so that the re-vaporized species from the walls can repeatedly impinge on the substrate, creating the desired "multi-shot" principle – <u>this "multi-shot" principle (i.e., the goal of using a "hot-wall") would not be achieved if the vaporized material undesirably deposited on the walls by any mechanism (i.e., condensation, decomposition, etc.).</u> Therefore, it would have been obvious to one of ordinary skill in the art to choose a reactor wall temperature that, while higher than the substrate temperature (i.e., in the "hot-wall" process / system taught by Suntola et al.) is below the thermal decomposition temperature of the reactants in order to prevent contamination of the reactor walls and allow re-vaporization from the walls as desired by Kim et al. and Suntola et al. In other words, it would have been obvious to one of ordinary skill in the art to select the substrate temperature and the reactor wall temperature (i.e., and thus the difference between the substrate and reactor wall temperatures) to maintain a lower rate of film growth upon the chamber walls as compared to the substrate with the reasonable expectation of (1) success, as Kim et al. teaches that the substrate and reactor wall temperatures can be separately controlled in their ALD process /

device, and (2) advantageously depositing a film by ALD on the substrate while achieving the desired "multi-shot" principle taught by Suntola et al.

30. Second and regarding Claims 31 – 43, the applicant argues that the cited combination of Kim et al. and Eichman et al. does not disclose that the temperature of the chamber walls is selected "to maintain a lower rate of film growth upon the chamber walls as compared to the substrate" because, in applying a <u>CVD</u> reactor cold wall design as taught by Eichman et al. to an ALD process, increased adsorption or even condensation of the reactants on the chamber walls can occur. The applicant makes similar arguments regarding Claims 44 – 49 and 50 – 56.

31. In response, the examiner maintains that the combination of Kim et al. and Eichman et al. at least reasonably suggests that the temperature of the chamber walls should be selected "to maintain a lower rate of film growth upon the chamber walls as compared to the substrate", as required by the applicant's claims. For example, Eichman et al. teaches that, in the art of manufacturing semiconductor devices by using a vapor deposition process, it is desirable to elevate (i.e., heat) the surface of the wafer to a reaction temperature while maintaining other parts of the reactor at a lower temperature, which <u>prevents the deposition of coating material on surfaces other than on the surface of the substrate to be coated</u> (Col.1, lines 18 – 34). Therefore, it would have been obvious to one of ordinary skill in the art to heat the surface of the wafer of Kim et al. to a desired reaction temperature while maintaining other parts of the reactor (e.g., the chamber walls) at a lower temperature with the reasonable expectation of successfully preventing deposition

of reaction materials on surfaces other than the substrate surface (i.e., the chamber walls). By maintaining the reactor walls at a temperature lower than the substrate temperature and minimizing deposition on the reactor walls (i.e., selecting a difference between the substrate temperature and the wall temperature to achieve a lower rate of film growth upon the chamber walls as compared to the substrate), one achieves the benefits of (1) preventing interference with reactor operation and (2) preventing substrate contamination (Col.1, lines 40 – 42 of Eichman et al.). In other words, Eichman et al. teaches that, by minimizing deposition on the reactor walls, one advantageously prevents interference with reactor operation and prevents substrate contamination. Therefore, it would have been obvious to one of ordinary skill in the art to utilize a chamber wall temperature that, while low enough to prevent deposition on the chamber walls (as taught by Eichman et al.), is high enough to prevent condensation and physisorption of one of the reactants on the walls in order to prevent contamination (i.e., contamination by <u>any mechanism</u>, including deposition, condensation, physisorption, etc.) of the reactor walls as desired by Kim et al. and Eichman et al. If, as proposed by the applicant, the reactor wall temperature was chosen to be so low that substantial condensation and/or adsorption of the reactants on the walls occurred, one of ordinary skill in the art would have expected to lose the benefits taught by Eichman et al. (i.e., preventing interference with reactor operation and preventing substrate contamination). Therefore, one of ordinary skill in the art would not have been expected to use a

reactor wall temperature that was so low that substantial condensation and/or adsorption of the reactants on the walls occurred.

32. Regarding new Claim 57 and the applicant's arguments regarding the same, the examiner has shown how the combination of Kim et al., Suntola et al., Yokoyama et al., and Lopatin et al. reasonably suggests all the limitations of the claim (see paragraph 19 above).

33. To conclude, the examiner stresses that, in order to establish obviousness under 35 U.S.C. 103, it must appear that the state of the relevant prior art was such that the claimed invention would have been obvious to one of ordinary skill in the art; in judging ordinary level of skill in the art, it is the level of those who normally attack the problems of the art that counts; people who do most of the problem solving in the art (i.e., in this case, the vapor deposition / CVD / ALD art) are graduate engineers; as such, they are chargeable with general knowledge concerning principles of engineering, outside the narrow field involved, and with skills, ingenuity, and competence of an average professional engineer (*Mueller Brass Co v. Reading Industries*, 176 USPQ 361, 369). As such, one of ordinary skill in the art would have readily recognized that, in a vapor deposition process, the walls of a reaction chamber should be maintained at a temperature which is sufficiently high to prevent condensation thereon, yet not so high that decomposition of the reactant(s) will occur, regardless of whether the vapor deposition process is an ALD process or a CVD process. For support of this state of the prior art, the examiner cites Akram (USPN 6,168,837 B1), Col.3, lines 29 – 42.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (703) 308-7557. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (703) 308-2333. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Wesley D Markham
Examiner
Art Unit 1762

WDM

WDM
June 20, 2003

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